MECHANICAL AND AEROSPACE ENGINEERING

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Minors:

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Mechanical engineers apply principles of motion, energy, force, materials, and mathematics to design and analyze a wide variety of products and systems. The field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, heat transfer, materials science and controls. Mechanical engineers use these core principles along with tools like computer-aided engineering and product life cycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, automotive systems, aircraft, robotics, medical devices, and more. Today, mechanical engineers are pursuing developments in such fields as composites, mechatronics, and nanotechnology, and are helping to create a more sustainable future.

The mechanical engineering curriculum serves as a broad-based education for positions in these diverse fields or for graduate study leading to advanced degrees. The first part of the mechanical engineering curriculum provides a firm foundation in mathematics, physics, chemistry, computer-aided drawing and conceptual design and the humanities. The second part of the curriculum provides the engineering science fundamentals and laboratory experiences necessary for testing and design, as well as continued learning in the humanities, arts, and social sciences. The final part of the curriculum emphasizes synthesis of knowledge through major design projects. The curriculum includes sufficient elective courses to permit a concentration in aerospace, energy systems and engineering as well as minors in several other areas.

Our mission is to educate excellent mechanical and aerospace engineers that lead the pursuit of the common good. We foster creativity and innovation to design and implement novel systems and solutions that make a difference. We employ innovative pedagogies, emphasize technical rigor and critical thinking, encourage students to make transdisciplinary connections, and integrate students into our scholarship. We provide practical and impactful experiential learning opportunities that inspire and prepare our students to realize their purpose and make a better future.

The University of Dayton Mechanical Engineering Program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. Our mechanical engineering program leads to the Bachelor of Mechanical Engineering degree. The department offers master's and doctoral degrees in both mechanical and aerospace engineering and a master's degree in renewable and clean energy engineering.

The education experience, guided by the University of Dayton Catholic and Marianist heritage, seeks to prepare graduates who will attain the following outcomes in preparation for entering the professional practice of engineering:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. An ability to communication effectively with a range of audiences

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Within the first several years following completion of the program, University of Dayton Bachelor of Mechanical Engineering graduates are prepared to meet the following program educational objectives:

- Acquire and retain challenging careers as innovative engineers in a wide variety of industries and professional organizations.
- Provide significant engineering expertise to their employer, continuing to learn new skills.
- Serve as responsible team members and aspire to leadership.
- Communicate effectively to both technical and nontechnical audiences.
- Establish a reputation for integrity, ethical conduct, and community service

Faculty

Jamie Ervin, Chairperson
Professors Emeriti: Chuang, Doepker, Eastep, Eimermacher, Jain, Schauer

Professors: Bigelow, Choi, Ervin, Hallinan, Kashani, Murray, Myszka, Pinnell, Rumpfkeil
Associate Professors: Chiasson, Gunasekaran, Kinney, Lowe, M. Reissman, T. Reissman, Subramanian
Assistant Professors: Amin, Kidambi, Mulford, Schrader, Wanstall
Senior Lecturer: Perkins
Lecturer: Narvaez, Ren

Bachelor of Mechanical Engineering (MEE) minimum 130 hours

The Common Academic Program (CAP) is an innovative curriculum that is the foundation of a University of Dayton education. It is a learning experience that is shared in common among all undergraduate students, regardless of their major. Some CAP requirements must be fulfilled by courses taken at UD (e.g., Capstone and Diversity and Social Justice). Some major requirements must also be fulfilled by courses taken at UD. Students should consult with their advisor regarding applicability of transfer credit to fulfill CAP and major program requirements.

Common Academic Program (CAP) [1]

First-Year Humanities Commons [2]		12 cr. hrs.
HST 103	Introduction to Global Historical Studies	
REL 103	Introduction to Religious and Theological Studies	
PHL 103	Introduction to Philosophy	
ENG 100	Writing Seminar I [3]	
Second-Year Writing Seminar [4]		0-3 cr. hrs.
ENG 200	Writing Seminar II	
Oral Communication		3 cr. hrs.
CMM 100	Principles of Oral Communication	
Mathematics		3 cr. hrs.
Social Science		3 cr. hrs.
Arts		3 cr. hrs.
Natural Sciences [5]		7 cr. hrs.
Crossing Boundaries		up to 12 cr. hrs.
Faith Traditions		
Practical Ethical Action		
Inquiry		
Integrative		
Advanced Study		
Philosophy and/or Religious Studies (6 cr. hrs.)		
Historical Studies (3 cr. hrs.) [6]		
Diversity and Social Justice [7]		3 cr. hrs.
Major Capstone [8]		0-6 cr. hrs.

1. The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student's degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student's major.
2. May be completed with ASI 110 and ASI 120 through the Core Program.
3. May be completed with ENG 100A and ENG 100B, by placement.
4. May be completed with ENG 114 or ENG 198 or ASI 120.
5. Must include two different disciplines and at least one accompanying lab.
6. May be completed with ASI 110 and ASI 120 through the Core Program.
7. May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student's major.
8. The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Major in Mechanical Engineering, BME

MATHEMATICS AND SCIENCE REQUIREMENTS		
MTH 168	Analytic Geometry & Calculus I	4
MTH 169	Analytic Geometry & Calculus II	4
MTH 218	Analytic Geometry & Calculus III	4
MTH 219	Applied Differential Equations	3
CHM 123	General Chemistry	3
PHY 206	General Physics I - Mechanics	3
PHY 210L	General Physics Laboratory I	1
or CHM 123L	General Chemistry Laboratory	
PHY 207	General Physics II - Electricity & Magnetism	3
Math/Science elective [1]		3
CORE MECHANICAL ENGINEERING COURSES		
EGR 102	Introduction to the University Experience for Engineers	0
EGR 103	Engineering Innovation	2
EGR 150	Enrichment Workshop I	0
EGR 200	Career Launchpad: Preparing for Success	0
EGR 201	Engineering Mechanics	3
EGR 300	Professional Development for Juniors	0
EGR 400	Professional Development for Seniors	1
EGM 202	Dynamics	3
EGM 303	Mechanics II	3
REQUIRED TECHNICAL COURSES		
MEE 101	Introduction to Mechanical Engineering II	0
MEE 104L	Solid Modeling in Design	2
MEE 114L	Introduction to Programming	1
MEE 202	Engineering Thermodynamics	3
MEE 205	Mechatronics	3
MEE 214	Programming for Mechanical Engineers	3
MEE 308	Fluid Mechanics	3

MEE 312 & 312L	Engineering Materials I and Materials Laboratory	4
MEE 321	Theory of Machines	3
MEE 341	Engineering Experimentation	3
MEE 344	Manufacturing Processes	3
or MEE 401	Aerodynamics	
or MEE 456	Energy Systems Engineering	
or MEE 473	Renewable Energy Systems	
MEE 410	Heat Transfer	3
MEE 427	Mechanical Design I	3
or MEE 425	Aerospace Design	
MEE 431L	Multidisciplinary Design I	2
MEE 432L	Multidisciplinary Design II	3
MEE 439	Dynamic Systems & Controls	4
or MEE 440	Flight Vehicle Performance	
MEE 460	Engineering Analysis	3
ELECTIVES		
Open electives [1]		6
Engineering Science Electives [1]		6
Total Hours		**98**

[1] Select from list approved by the Mechanical and Aerospace Engineering Department.

Concentration in Aerospace Engineering (AEE)

This concentration is open only to mechanical engineering majors. The program provides a strong background for career specialization in the fields of aircraft and aerospace engineering.

MEE 225	Introduction to Flight	3
MEE 401/ AEE 501	Aerodynamics	3
MEE 409	Aerospace Structures	3
MEE 425	Aerospace Design	3
MEE 440/ AEE 521	Flight Vehicle Performance	3
Select one course from:		3
MEE 413/ AEE 513	Propulsion	
Approved aerospace engineering course		
Total Hours		**18**

Concentration in Energy Systems-Mechanical (MRS)

This concentration is open to all engineering students.

Select two courses from:		6
ASI 320	Cities & Energy	
CEE 434	Water & Wastewater Engineering	
ECO 435	Economics of the Environment	
PHL 321	Environmental Ethics	
POL 371	Environmental Policy	
SEE 301	Earth Systems & Global Climate Change	
SEE 401	Sustainability Research I	
Any approved Arts and Science energy/sustainability related elective		
Select four courses from:		12
MEE 344	Manufacturing Processes	
MEE 413	Propulsion	
MEE 420	Energy Efficient Buildings	
MEE 456	Energy Systems Engineering	
MEE 457	Building Energy Informatics	
MEE 461	Solar Energy Engineering	
MEE 462	Geothermal Energy Engineering	
MEE 464	Sustainable Energy Systems	
MEE 471	Design of Thermal Systems	
MEE 472	Design for Environment	
MEE 473	Renewable Energy Systems	
MEE 493	Honors Thesis	
MEE 565	Fundamentals of Fuels & Combustion	
RCL 507	Materials Advanced Energy Applications	
RCL 511	Advanced Thermodynamics	
RCL 524	Electrochemical Power	
RCL 533	Biofuel Production Processes	
RCL 556	Energy Systems Engineering	
RCL 557	Building Energy Informatics	
RCL 561	Solar Energy Engineering	
RCL 562	Geothermal Energy Engineering	
RCL 563	Wind Energy Engineering	
RCL 564	Sustainable Energy Systems	
RCL 568	Internal Combustion Engines	
RCL 569	Energy Efficient Buildings	
RCL 571	Design of Thermal Systems	
RCL 572	Design for Environment	
RCL 573	Renewable Energy Systems	
RCL 583	Advanced Photovoltaics	
RCL 590	Special Problems in Renewable & Clean Energy	
RCL 595	Renewable & Clean Energy Project	
Any approved engineering energy/sustainability related elective		
Total Hours		**18**

Minor in Aerospace Engineering (AEE)

This minor is open to chemical, civil, and mechanical engineering majors. The program provides a strong background for career specialization in the fields of aircraft and aerospace engineering. Only one course may double count for both the student's major and minor.

MEE 225	Introduction to Flight	3
Select one course from:		3
MEE 401	Aerodynamics	
MEE 440	Flight Vehicle Performance	
Select two courses from:		6
MEE 409	Aerospace Structures	
MEE 413	Propulsion	

Approved aerospace course(s)	
Total Hours	**12**

Only one course may double count for both the student's major and minor.

Minor in Human Movement Biomechanics (HMB)

This minor focuses on the theory and techniques in the field of biomechanical engineering to understand the kinematics and kinetics of human motion. Courses in the minor will prepare students to apply mechanical engineering concepts to solve clinical, occupational, and sports biomechanics problems. Only one course may double count for both the student's major and minor.

MEE 230	Introduction to Biomechanics	3
MEE 430/530	Biomechanical Engineering	3
HSS 206	Fundamentals of Human Anatomy and Physiology	3
Select one:		3
MEE 450/531	Experimental Methods in Biomechanics	
MEE 454/554	Biomechanical Modeling	
MEE 486/586	Human Movement Assessment	
Approved minor elective		
Total Hours		**12**

Only one course may double count for both the student's major and minor.

First Year

Fall	Hours	Spring	Hours
ENG 100 (Satisfies CAP Writing Seminar)	3	REL 103 (Satisfies CAP First Year Hummanities Commons)	3
PHL 103 (Satisfies CAP First-Year Hummanities Commons)	3	CMM 100 (Satisfies CAP Communication)	3
HST 103 (Satisfies CAP First-Year Hummanities Commons)	3	CHM 123	3
PHY 206	3	MTH 169	4
PHY 210L	1	MEE 104L	2
MTH 168 (Satisfies CAP Math Requirement)	4	EGR 103	2
MEE 114L	1	MEE 101	0
EGR 150	0		
EGR 102	0		
	18		**17**

Second Year

Fall	Hours	Spring	Hours
ENG 200 (Satisfies CAP Second Year Writing Seminar)	3	SSC 200 (Satisfies CAP Social Science)	3
PHY 207	3	MEE 205	3
MTH 218	4	MEE 214	3
EGM 201	3	MTH 219	3
MEE 202	3	EGM 202	3
EGR 200	0		
	16		**15**

Third Year

Fall	Hours	Spring	Hours
CAP Advanced PHL/REL (may also satisfy additional CAP components)	3	CAP Advanced PHL/REL (may also satisfy additional CAP components)	3
MEE 312	3	Open Elect	3
MEE 312L	1	MEE 341	3
MEE 321	3	MEE 344 (or equivalent)	3
EGM 303	3	MEE 410	3
MEE 308	3		
EGR 300	0		
	16		**15**

Fourth Year

Fall	Hours	Spring	Hours
CAP ART (may also satisfy additional CAP components)	3	CAP Advanced HST (may also satisfy additional CAP components)	3
MTH/SCI EL	3	Open Elect	3
MEE 427	3	MEE 432L (Satisfies CAP Capstone Requirement)	3
MEE 431L	2	MEE 460	3
MEE 439	3	Engineering Science Elective	3
Engineering Science Elective	3	EGR 400	1
	17		**16**

Total credit hours: 130

Courses

MEE 101. Introduction to Mechanical Engineering II. 0 Hours
Second semester of introduction to Mechanical Engineering. Seminars on course selection, campus policies, safety, and health. Introductions to campus services for learning, counseling, coop and job placement.

MEE 104L. Solid Modeling in Design. 2 Hours
Introduction to engineering graphics and visualization. Instruction on sketching methods and proper techniques for parametric, solid modeling using computer aided design (CAD) software. Students will interpret and develop technical drawings that are used to communicate mechanical designs.

MEE 114L. Introduction to Programming. 1 Hour
Introduction to applications and use of computer programs for mechanical engineers with concentration on spreadsheets, plotting, data manipulation and basic programming.

MEE 198. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 202. Engineering Thermodynamics. 3 Hours
This course provides an introduction to engineering thermodynamics, emphasizing the vital importance of energy generation and efficiency from the perspective of the Mechanical Engineering discipline. State descriptions of pure substances and mixtures. Control volume analysis and conservation principles applied to systems with respect to mass, energy, and entropy with applications to power, refrigeration and other energy conversion systems. Introduces a common problem-solving approach and processes to address real, open ended problems and creative application of theory. Prerequisites: MTH 168.

MEE 204. Introduction to Robot Design. 3 Hours
Mechanical design aspects of robotic and automation systems. Employing the innovation process as applied to automation systems with an emphasis on detailed mechanical design techniques, standards and guidelines. Experience is gained by completing individual and team design projects. Prerequisite(s): EGR 103 and MEE 104L.

MEE 205. Mechatronics. 3 Hours
This course provides an introduction to the cross-disciplinary topic of Mechatronics, a blend of Mechanical, Electrical, and Computer Engineering. Topics include principles of linear circuit analysis and problem solving techniques (both analytical and computer solutions) associated with analog circuits containing both passive and active components. Students are introduced to DC, AC, and transient circuit analyses. In addition to these fundamentals, the “mechatronics emphasis” involves practical experience in creating robotic and automated systems. Related to its Integrative component within CAP, students discuss and reflect on the social impact such technology has within their lives, their future profession, and the world as a whole. Building upon the course's role as an elective within the Engineering in Human Rights Minor, these reflections focus on the role that mechatronics can and should play to foster human rights, such as protecting people from “dull, dirty, and dangerous” work, or ensuring how designers in mechatronics do not contribute to human rights violations. Ultimately, students scaffold their knowledge through a series of microprocessor programming modules which culminate in student teams designing, fabricating, and programming an autonomous system that could contribute to the enjoyment of human rights. Prerequisites: MTH 168 and MEE 114L.

MEE 214. Programming for Mechanical Engineers. 3 Hours
Detailed introduction to solving engineering problems through computational methods. Fundamentals of programming in MATLAB involving arrays, functions, decision making, loops, and graphing. Emphasis on numerical methods that are applied in engineering. Prerequisites: MTH 169; MEE 114L.

MEE 225. Introduction to Flight. 3 Hours
An introductory course designed to provide students with a basic understanding of the multitude of disciplines that comprise the aeronautical engineering profession. A background and brief history of flight are covered. Foundational knowledge of aerodynamics, propulsion, aerostructures, aircraft performance and aerospace vehicle design. Laboratory included. Prerequisite(s): PHY 206.

MEE 230. Introduction to Biomechanics. 3 Hours
Introduction to the field of biomechanical engineering with an emphasis on human movement. Application of engineering concepts to solve clinical, occupational, and sports biomechanics problems with a focus on experimental data analysis, kinematics, research, product design, and technical reporting. Corequisite: EGR 201 or permission of instructor. Prerequisite(s): PHY 206 or permission of instructor.

MEE 298. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 300. Professional Development for Juniors. 0 Hours
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE juniors. Prerequisite(s): MEE 200 or COP 200 or EGR 200.

MEE 308. Fluid Mechanics. 3 Hours
An introductory course in fluid mechanics. Fundamental concepts including continuity, momentum, and energy relations. Control volume analysis and differential formulations. Internal and external flows in laminar and turbulent regimes. Prerequisite(s): MEE 202 OR EGR 202. Corequisite(s): MTH 219.

MEE 312. Engineering Materials I. 3 Hours
Atomic structure, bonding, and arrangement in solids. Mechanical and physical properties of solids, phase equilibria, and processing of solids. Strengthening methods in solids, principles of material selection, and characteristics of non-ferrous alloys, polymers, ceramic composites, and construction materials.

MEE 312L. Materials Laboratory. 1 Hour
Conducting mechanical and physical tests on solids including, but not limited to tension, compression, bending, hardness, and impact. Metallographic examination of surfaces. Test standards, data reduction, analysis, interpretation, and written and oral communication of test results. Corequisite(s): MEE 312.

MEE 321. Theory of Machines. 3 Hours
Analysis and synthesis of mechanisms using analytical and computer-based techniques. Applications include cams, gears, and linkages such as four-bar, slider-crank, and quick-return mechanisms. Gear train specification and force analysis. Position, velocity, and acceleration analysis and mechanical advantage of a wide variety of linkage systems. Prerequisites: EGR 201. Corequisites: MEE 214 or MEE 314 or ECE 203.

MEE 341. Engineering Experimentation. 3 Hours
Basic sensors and instrumentation, design of experiments, data acquisition and processing, and uncertainty and statistical analysis of data. Measurement of strain, motion, pressure, temperature, flow and sound. Measurement applications to engineering phenomena or systems. Course will utilize a mix of lecture, laboratory experiments, and demonstrations. Also a term project to provide design of experiment experience. Corequisites: EGR 203 or MEE 205 or ECE 201.

MEE 344. Manufacturing Processes. 3 Hours
Casting processes including casting defects and design of castings; metal working processes such as extrusion, forging, rolling and wire drawing; sheet metal forming; welding processes; powder metallurgy and design principles for P/M parts, metal removal processes; forming and shaping plastics and composite materials; rapid prototyping. Design principles for manufacturability. Includes laboratory. Prerequisite(s): MEE 312.

MEE 398. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 400. Professional Development for Seniors. 1 Hour
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE seniors. Prerequisites: MEE 300 or COP 101.

MEE 401. Aerodynamics. 3 Hours
Fundamentals of steady and inviscid aerodynamic flows. Emphasis on force and moment determination for airfoils and finite wings. Prerequisite(s): MEE 308.

MEE 409. Aerospace Structures. 3 Hours
Structural properties of wing and fuselage sections. Nonsymmetrical bending of skin-stringer wing sections. Shear stresses in thin-walled and skin-stringer multiple-celled sections. Deflection by energy methods. Introduction to finite element stiffness method. Prerequisite(s): EGM 303.

MEE 410. Heat Transfer. 3 Hours
Fundamentals of conduction, convection, and thermal radiation energy transfer. Conduction of heat in steady and unsteady state. Principles of boundary layer theory applicable to free and forced convection heat transfer for internal and external flows. Radiation analysis with and without convection and conduction. Prerequisite(s): MEE 308.

MEE 413. Propulsion. 3 Hours
Principles of propulsive devices, aerothermodynamics, diffuser and nozzle flow, energy transfer in turbo-machinery; turbojet, turbo-fan, prop-fan engines; turbo-prop and turboshaft engines. RAM and SCRAM jet analysis and a brief introduction to related materials and air frame-propulsion interaction. Prerequisite(s): (MEE 225; MEE 308) or instructor permission.

MEE 417. Internal Combustion Engines. 3 Hours
Combustion and energy release processes. Applications to spark and compression ignition, thermal jet, rocket, and gas turbine engines. Emphasis on air pollution problems caused by internal combustion engines. Idealized and actual cycles studied in preparation for laboratory testing of I. C. engines. Prerequisite(s): EGR 202 or permission of instructor.

MEE 420. Energy Efficient Buildings. 3 Hours
Provides knowledge and skills necessary to design and operate healthier, more comfortable, more productive, and less environmentally destructive buildings. A specific design target of E/3 (typical energy use divided by three) is established as a goal. Economic, thermodynamic, and heat transfer analyses are utilized. Extensive software development. Prerequisite(s): MEE 410.

MEE 421. Robot Modeling. 3 Hours
This course provides the fundamentals of modeling the movement of spatial systems with a focus on robots, particularly industrial robots. Topics include planar and spatial robotics, forward kinematics including the Denavit-Hartenberg formalism, inverse kinematics, manipulator velocities and the robotics-specific Jacobian, static loads in robots, and the product-of-exponentials formalism. Prerequisites: MEE 321 or (ECE 203 and third-year status in ECE).

MEE 425. Aerospace Design. 3 Hours
Capstone Air Vehicle Design project that involves both individual and team-based conceptual and preliminary design and sizing. This course integrates the knowledge acquired from the disciplinary subjects already taken (aerodynamics, aerospace structures, propulsion, flight dynamics and intro to flight) in order to size an air vehicle based on a set of requirements. Prerequisites: MEE 225; MEE 401 or AEE 501; MEE 440 or AEE 521 or permission of instructor.

MEE 427. Mechanical Design I. 3 Hours
Stress and deflection analysis of machine components; theories of failure; fatigue failure of metals. Design and analysis of mechanical components such as gears, shafts, bearings and springs. Prerequisite(s): EGM 303; MEE 321.

MEE 428. Mechanical Design II. 3 Hours
Advanced topics in stress and deflection analysis; analysis and design of mechanical elements such as gears, journal and ball bearings, belts, brakes, and clutches; principles of fracture mechanics; failure analysis; machinery construction principles. Contemporary design methods and issues associated with the product development cycle. Prerequisite(s): MEE 427.

MEE 430. Biomechanical Engineering. 3 Hours
Application of engineering principles to clinical, occupational, and sports biomechanics topics. The course focuses on biomechanical analysis, particularly kinematics and kinetics of human movement, with emphasis on both research and product design.

MEE 431L. Multidisciplinary Design I. 2 Hours
Application of engineering fundamentals to sponsored multidisciplinary-team design projects. In a combination of lecture and lab experiences, students learn the product realization process and project management. Product realization topics include idea generation, proposal development, design specifications, conceptualization and decision analysis. Project management topics include cost estimation and intellectual property management. Design projects progress to the proof of concept and prototype development stages. Prerequisites: MEE Students: EGM 303 and MEE 321, ECE students: ECE 303 and (ECE 304 or ECE 314). Corequisites: (MEE 344 or MEE 473 or MEE 456 or MEE 401 or MEE 409).

MEE 432L. Multidisciplinary Design II. 3 Hours
One hour lecture and five hours of lab per week. Detailed evaluation of the Product Realization Process focusing on conceptual design, embodiment design, final design and prototyping is taught. Analysis of the design criteria for safety, ergonomics, environment, cost and sociological impact is covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. Prerequisites: MEE majors: MEE 431L; CPE majors: ECE 431L and (2 of the following: ECE 334, ECE 340, CPS 356, ECE 449); ELE majors: ECE 431L and (2 of the following: ECE 415, ECE 334, ECE 340).

MEE 437. Autonomous Systems. 3 Hours
At the intersection of mechanical engineering, electrical engineering, and computer science, autonomous systems involve the implementation of mechatronic technologies which operate independently (autonomously) from human intervention. This course emphasizes the practical implementation of modern control systems for the purposes of creating fully- or semi-autonomous systems. Topics include programming syntax and structure, integration of peripherals (sensors and actuators) with controllers, and data communications both within and external to the systems. Equal mix of lecture and laboratory with significant time dedicated to design projects. Prerequisite(s): (ECE 201 or EGR 203) and (ECE 201L or EGR 203L) or MEE 205.

MEE 438. Applied Robotics. 3 Hours
Within this course, focus will be on project-based learning with robotic systems. Extensive usage of student kits and industrial robotic platforms will enable hands-on learning experiences, which will encourage students to think critically and deepen their knowledge through experimentation. Using a combination of online learning content and classroom lectures, multiple comprehensive projects will be covered, such as a drawing robot, a webcam-controlled rover or industrial arm, and/or a self-balancing motorcycle. Students will use software (MATLAB, Simulink, ROS) programming to implement model-based design, control systems, image and signal processing, and more. The major learning objective is for students to get prepared for real-life environments by using the same tools as industry professionals. Prerequisites: MEE 321.

MEE 439. Dynamic Systems & Controls. 3 Hours
Dynamic systems modeling with special emphasis on mechanical systems (one and two degrees of freedom). Covers both transfer function and state space modeling techniques. Analogues drawn between mechanical, electrical, fluid, and thermal physical domains. System nonlinearities and model linearization methods are discussed. Analytical solutions of linear ordinary differential equations using Laplace transformation and state space theory. Feedback control theory, including root locus and frequency response techniques. Prerequisite(s): EGM 202; MTH 219.

MEE 440. Flight Vehicle Performance. 3 Hours
This course is intended to introduce the student to the flight mechanics of aerospace vehicles. Some familiarity with aircraft performance, static stability and control is assumed, but not required. We will use modern analysis methods to develop the topical details including: 1) a study of aerodynamics involved in-flight vehicle motion to obtain an understanding of influence coefficients; 2) use of linear algebra to develop a rational approach to modeling aircraft dynamics; 3) an introduction to modern control theory methodology; and 4) problems and examples that illustrate the use of desktop computational tools currently available. Prerequisite(s): (EGM 202; MEE 225; MTH 219) or permission of instructor.

MEE 450. Experimental Methods in Biomechanics. 3 Hours
This course is focused on developing and applying advanced experimentation skills with a specific focus on techniques associated with the study of human movement. Emphasis on equipment and technology, data analysis and interpretation, statistical methods, and technical reporting. Prerequisite(s): MEE 341 Engineering Experimentation or permission of instructor.

MEE 454. Biomechanical Modeling. 3 Hours
The course will focus on biomechanical modeling, specifically, computational modeling of the human body's bones, joints, and muscles and the motion of the human body. Emphasis on representing aspects of the body computationally (through equations and as mechanical systems) and applying modeling and simulation to analyze the motion of a human.

MEE 456. Energy Systems Engineering. 3 Hours
This course is aimed at providing fundamental knowledge of thermodynamics, fluid mechanics, and heat transfer in context of Energy Systems Engineering. A Just-in-Time approach to learning and applying these topics will be used. Projects will anchor all class activities. In addition to providing knowledge and experience of thermodynamics, fluid mechanics, and heat transfer, this course seeks to provide students the analysis skills necessary to determine the importance of energy conversion technologies, with special emphasis on energy efficiency and renewable energy (tidal, hydroelectric, wind, solar and geothermal). Corequisite(s): MEE 410.

MEE 457. Building Energy Informatics. 3 Hours
The focus of the course is the collection and analysis of energy data sets to reduce energy consumption and/or energy demand. Students will typically utilize monthly energy data from multiple buildings, real time energy data, and building energy audit data. Students will disaggregate/aggregate data to develop energy use benchmarks, identify priority buildings/actions for energy reduction, identify problems, and estimate savings. Programming in Matlab and an introduction to sql dbase management are covered. Corequisite(s): MEE 410.

MEE 460. Engineering Analysis. 3 Hours
Engineering Analysis: Entry into AI-supported modeling of engineering systems. Emphasis on open-ended projects leading to data-based machine learning models and subsequent application of models to develop new solutions and insights. Identification and problem definition are relative to provided data. Classification and regression model approaches are considered. Statistical analysis is used to characterize model domain applicability, correlation, and co-linearity. Stacking benefits to reduce over-fitting in model development is demonstrated. Post-model development analysis involving optimization and/or Monte Carlo analysis to quantify uncertainty is considered. Effective communication of modeling, simulation, results, and conclusions is expected. Prerequisites: MTH 219.

MEE 461. Solar Energy Engineering. 3 Hours
This course will cover the theory, design and application of two broad uses of solar energy: (i) direct thermal and (ii) electrical energy generation. The majority of the course will focus on thermal applications, with emphasis on system simulation and design for buildings and other systems. This course will expose students to the development and use of solar design and simulation tools. Most of the tools will be implemented in Excel and TRNSYS, but students are welcome to use other software tools such as Engineering Equation Solver, (EES) or MATLAB. Some of the class time will be devoted to demonstrate the development and use of these tools to solve homework problems. Corequisite(s): MEE 410.

MEE 462. Geothermal Energy Engineering. 3 Hours
This course will cover the theory and design of three broad uses of geothermal energy: (i) heat pump applications, (ii) direct uses, and (iii) electrical energy generation. The majority of the course will focus on heat pump applications, with emphasis on ground heat exchanger simulation and design for buildings and other systems. Closed-loop, open-loop, and hybrid geothermal heat pump systems will be examined. Heating, cooling, and electricity generating applications using hot geothermal reservoirs will also be discussed. This course will expose students to the development and use of geothermal design and simulation tools. Most of the tools will be implemented in Excel, but students are welcome to use other software tools such as Engineering Equation Solver (EES) or MATLAB. The course notes explain the development and use of these tools, which will be used to solve homework problems. Corequisite(s): MEE 410.

MEE 463. Wind Energy Engineering. 3 Hours
Introduction to wind energy engineering, including wind energy potential and its application to power generation. Topics include wind turbine components; turbine fluid dynamics and aerodynamics; turbine structures; turbine dynamics, wind turbine controls; fatigue; connection to the electric grid; maintenance; web site assessment; wind economics; and wind power legal, environmental, and ethical issues. Corequisite(s): MEE 410.

MEE 464. Sustainable Energy Systems. 3 Hours
Survey of conventional fossil-fuel and renewable energy with an emphasis on system integration. Basic concepts of climate physics will be addressed along with estimates of fossil resources. Corequisite(s): MEE 410.

MEE 472. Design for Environment. 3 Hours
Emphasis on design for environment over the life cycle of a product or process, including consideration of the mining, processing, manufacturing, use, and post-life stages. Course provides knowledge and experience in invention for the purpose of clean design, life cycle assessment strategies to estimate the environmental impact of products and processes, and cleaner manufacturing practices. Course includes a major design project.

MEE 473. Renewable Energy Systems. 3 Hours
Introduction to the impact of energy on the economy and environment. Engineering models of solar thermal and photovoltaic systems. Introduction to wind power. Fuel cells and renewable sources of hydrogen.

MEE 474. Sustainable Energy Systems in Developing Countries. 3 Hours
Overview of the importance of access to sustainable modern energy systems for developing countries. Both sustainable development and human rights will be important themes. Specific technologies will be studied, along with the benefits and challenges of these technologies to sustainable energy systems, with comparisons made to current energy systems. Energy system modeling will be used to explore options for energy system transformation in selected Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

MEE 486. Human Movement Assessment. 3 Hours
Students will learn the practical skills to collect data about human movements. Students will learn the analysis skills to process that data and extract important metrics from the data. Students will be able to create and interpret common biomechanical metrics such as kinematic profiles. Human movements related to clinical applications and sports applications will be studied.

MEE 490. Special Topics in Mechanical & Aerospace Engineering. 3 Hours
Particular assignments to be arranged and approved by the department chairperson.

MEE 493. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program.

MEE 494. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program. Prerequisite(s): MEE 493.

MEE 498. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 499. Special Problems in Mechanical & Aerospace Engineering. 1-6 Hours
Particular assignments to be arranged and approved by department chairperson.